1,168,851

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,168,851

Date of Application and filing Complete Specification: 14 March, 1967.

No. 11962/67.

Application made in Switzerland (No. 3896) on 16 March, 1966.

Complete Specification Published: 29 Oct., 1969.

Index at acceptance:—H1 K(211, 217, 225, 312, 37Y, 37X, 381, 38Y, 383, 385, 386, 402, 404, 441, 455, 518, 51X)

International Classification:—H 01 I 1/00

COMPLETE SPECIFICATION

Semiconductor Rectifier Device in Parallel Connection

We, SOCIETE ANONYME DES ATELIERS DE SECHERON, a Swiss Corporation, of Avenue de Secheron, Geneva, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

If one wishes to increase the nominal current of a semiconductor rectifier element, one is faced with several important difficulties. If the diameter of the crystal, made for example of silicon, is increased from 20 to 30 or 40 mm and more, the number of imperfections in the crystal increases at the same time. Moreover, the mechanical fatigue increases also, as it is due to the difference in thermal expansion of the silicon crystal and of the anode and cathode metals.

If two or more semiconductor rectifier elements are connected in parallel, good distribution of the current between the different elements is not assured, since the current through any element increases as its voltage diminishes which happens when it heats. This imbalance in current distribution is often reduced by the use of compensating elements.

Alternatively the rectifier elements are connected in a common encapsulation on one or both sides to metal pieces which act as thermal bridges. Such connection is effected by soldering the rectifier elements to the metal pieces or by interposing springs between the elements and the metal pieces.

The present invention aims at achieving efficient electrical and thermal bridging in a simpler and cheaper manner.

According to the present invention a semiconductor rectifier device comprising at least two elements in parallel is formed by placing the rectifier elements in the same encapsulation and pressing them between two heavy metal pieces which make continuous electrical and thermal connection over substantially the whole of each side of each element.

By placing the different elements in the same encapsulation, they are adways surrounded by the same atmosphere, which assists in reducing differences in electrical surface phenomena. Preferably, the encapsulation is hermetically sealed or even vacuum tight.

Figures 1, 2, 3, 4 and 5 of the attached drawing show, as examples, different embodiments of the invention.

Figure 1 shows two rectifier elements 1 and 11 in parallel in the same encapsulation formed by metals 4 and 44 and insulator 5. A thermal bridge is formed by the two heavy metal pieces 6 and 66 which are strongly pressed against the encapsulation by insulated nuts and bots which run in the channels 17 and 18. The two rectifier elements 1 and 11 are each composed of a semiconductor crystal, for example of silicon, with an interior zone n of high resistivity and two exterior zones p and n+, highly doped, and, in addition, metallic anodes 2 and 22 respectively, as well as metallic cathodes 3 and 33 respectively. Good electrical contact between the anodes 2 and 22 and the metallic encapsulation 4 on the one hand and between cathodes 3 and 33 and the encapsulation 44 on the other is achieved by the strong mechanical pressure exerted by the two metallic pieces 6 and 66 which make continues electrical and thermal connection over the whole of each side of the elements 1 and 11. These two pieces may be made, for example, of copper or aluminium; and they may have ribs, in which cooling fluid may flow.

In Figures 2 and 3, the thermal bridge is formed by pieces 7 and 77 having large cross sections and very good thermal conductivity. In Figure 2, these two pieces form part of the encapsulation; in Figure 3, they are found inside the encapsulation, but the thermal

contact is always maintained by the pieces 6 and 66.

In another embodiment, three or more rectifier elements could be provided for in the same encapsulation.

Figures 2 and 5 show two controlled rectifier elements. In the case of Figure 5, each gate electrode 8 and 88 is connected by a separate wire and a separate insulator (which is not shown) to exterior terminals 10 and 100 respectively. In the case of Figure 2, these control electrodes are connected on the inside by resistors 9 and 99 respectively to a common electrode 10 with a single inlet insulator. The controlled rectifiers have four layers p-n-p-n. The resistors 9 and 99 can be omitted if the two rectifier elements 1 and 11 have sufficiently similar characteristics.

Figure 4 shows a single electrode 10 on the outside which feeds the primary side 12 of a small pulse transformer which is inside the encapsulation; the secondary windings 13 and 14 are connected by diodes 15 and 16 and resistors 9 and 99 to the gate electrodes 8 and 88.

In Figure 5, the two large cross-sectioned metal pieces form part of the encapsulation and, at the same time, constitute the thermal bridge. The insulator 5 is made, for example, of synthetic silicone material or material of organic origin. The joint between pieces 5—6—66 is effected by well known techniques. Electrodes 8 and 88 are connected to exterior terminals 10 and 100 respectively by wires which are hermetically sealed in the insulator 5.

If three rectifier elements are placed in parallel in the same encapsulation, they can be arranged in a triangle. But when there is a great number, they can be arranged in a straight line.

WHAT WE CLAIM IS:—

1. Semiconductor rectifier device comprising at least two rectifier elements in parallel, in which the rectifier elements are placed in the same encapsulation and are pressed between two heavy metal pieces which make continuous electrical and thermal connection over substantially the whole of each side of each element.

2. Device according to claim 1, in which the two heavy metal pieces are placed on the outside of the encapsulation.

3. Device according to claim 1, in which the two heavy metal pieces form part of the encapsulation.

4. Device according to claim 1, in which the two heavy metal pieces are placed on the inside of the encapsulation.

5. Device according to claim 1, in which the rectifier elements each have a control gate electrode.

6. Device according to claim 5, in which the gate electrodes of the rectifier elements are electrically connected within the encapsulation.

7. Device according to claim 5 or claim 6, characterised by the fact that the gate electrodes of the rectifier elements are electrically connected by means of resistors.

8. Device according to claim 5, in which the gate electrodes of the rectifier elements are connected to the secondary windings of a transformer placed inside of the encapsulation.

For the Applicants:
GILL, JENNINGS & EVERY,
Chartered Patent Agents,
51/52 Chancery Lane,
London, W.C.2.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1969.
Published by the Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

1168851 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1.

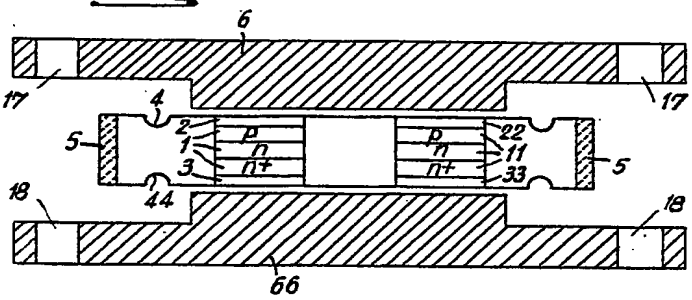

Fig. 2.

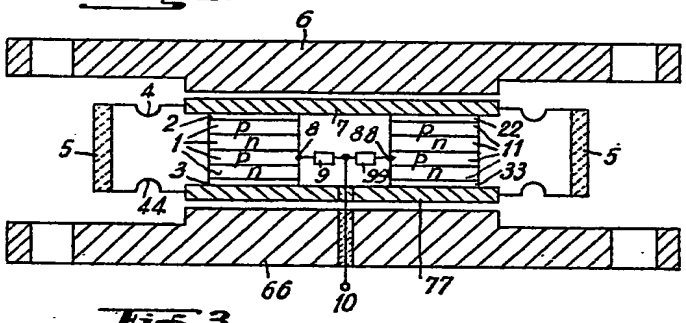

Fig. 3.